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SUBJECT: Sixteenth S-IVB Stage Project Review, Douglas Aircraft Company, January 17, 1967 - Case 320

DATE: January 24, 1967

FROM: D. S. Lopez

ABSTRACT

The sixteenth S-IVB Stage Project Review was held on January 17, 1967.

Flight data from AS-202 has revealed several problems. The LH_2 boiloff in orbit was 60% higher than predicted. The S-IVB stages for AS-501, 502 and 503 will be instrumented to obtain additional data. Also, the crossover duct between the turbopump turbines experienced much higher temperatures than during ground test. This adversely affects the restart of the J-2. Several fixes are being studied.

The retrorockets have been modified as a result of a possible burn through on one of the retros on AS-202. MSFC will decide whether to use the original or modified rockets on AS-204 since qualification testing is not completed on the modified rockets.

DAC and MSFC briefed on the guidelines for AAP #2 (S-IVB orbital workshop) and on the status of various modifications for the orbital workshop.

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MEMORANDUM FOR FILE

The sixteenth S-IVB Stage Project Review was held at the Missiles and Space Systems Division of Douglas Aircraft Company (DAC), Huntington Beach, California on January 17, 1967. Significant items and discussions are as follows:

1. The injector design problems on the O_2/H_2 burner, used to heat helium for repressurization of the LOX and LH_2 tanks prior to restart, have been solved. However, the LH_2 duct has been modified due to failures during vibration testing. The modified duct is presently being retested. The O_2/H_2 burner will be test fired on the 503 stage this week. The burner system plus a back-up ambient system of pressurized spheres will be installed on stages 503 and subsequent.

2. The boiloff of the LH_2 in orbit on AS-203 was 60% greater than predicted (approximately 2400 lbs. vs 1400 lbs.). At least part of it was due to greater than planned heat flow through the tank walls. The 501, 502 and 503 stages will be instrumented to obtain more data on the boiloff mechanism. As a first step, the stage will be repainted with an aluminum silicon paint which should reduce boiloff by about 300 lbs. This will be done on 501 only if no schedule slippage results.

3. On AS-202, one of the retrorockets had a pressure tailoff about 0.2 seconds early due to a suspected burn through of the case. Checking revealed that hot spots had occurred on 3 of 12 retrorocket cases during earlier ground testing. As a result DAC and Thiokol have modified the retrorockets by an additional liner to protect the case in the burn through area and have added an inhibitor to prevent end burning. Tests

[redacted]

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of these rockets resulted in much lower temperatures on the case wall. DAC feels that the modified rockets can be used on 204 without additional qualification testing. MSFC must decide by January 20, whether to use the old rockets, the modified rockets or the old rockets with additional X-ray inspection (inspection will take about four days). The early decision is required as installation of the retrorockets is to start by the end of the month.

4. The crossover duct which carries the exhaust gases from the LH_2 turbopump turbine to drive the LOX turbopump turbine experienced much higher temperatures on the 203 flight than on ground tests. The temperature was about 175°F at completion of the first orbit. This affects the restart of the J-2 as so much energy is added to the start tank hydrogen as it flows through the hot duct during the start sequence that turbine overspeed and gas generator exhaust temperature limits are exceeded. Rocketdyne, as a result of calculations backed up by testing, has determined that the turbine speed and exhaust gas temperature can be brought within limits at restart by painting the duct with high emissivity paint and by setting the propellant utilization valve wide open (4.5 M/R) during the start rather than in the null position (5.0 M/R). Additional fixes are being studied.

   The crossover ducts for AS-204 and 206 have been instrumented so that further data may be obtained. Rocketdyne wants to remove, paint and reinstall the duct for 204 in order to get the maximum possible data on the fix prior to AS-501, when restart will be accomplished. The painting and installation requires a minimum of 3 days and it might delay the launch date of 204. MSFC will determine the launch date impact and advise Rocketdyne whether to paint the duct or leave it unpainted for 204.(1)

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(1) MSFC has decided, as of January 20, 1967, that the duct will not be removed for painting. Rocketdyne is checking on the possibility of partially painting the duct without removal.

5. MSFC presented the guidelines for the orbital workshop mission (AAP #2). Some of these are:

   a. passive attitude control required
   b. orbital lifetime of two years
   c. pure O_2 life support for 30 day missions, 69% O_2 and 31% N_2 for more than 30 days
   d. minimize EVA
   e. subsystems reactivation capability for revisits.

6. DAC discussed the status of various components of the S-IVB orbital workshop.

   a. Meteoroid Protection - DAC recommends an extensible aluminum bumper around the LH_2 tank which stands off five inches when extended. Protection is definitely required on a 56 day mission. A 30 day mission is marginal.

   b. Quick Opening Hatch - A working mockup of a hatch to be removed when the airlock is docked was delivered to MSFC. It is pneumatically actuated with a manual back-up. MSFC has made several in-house designs and will select one for test with DAC help.

   c. Fire Retardant Liner - Decision has to be made between aluminum foil and dynatherm. An eight foot tank simulation, lined half with aluminum and half with dynatherm is now at SACTO for testing. Tests will determine capability of bonding to withstand vibration, pressure, cryogenic environment etc. DAC prefers aluminum if these tests give similar results for aluminum and dynatherm. Dynatherm is more expensive, more toxic and AEDC flammability tests favored aluminum.

The complete minutes of this meeting should be available in two weeks.

D. S. Lopez

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